INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : F28F 3/00, 3/12, 27/02

A1

(11) International Publication Number: WO 94/14021

(43) International Publication Date: 23 June 1994 (23.06.94)

(21) International Application Number: PCT/AU93/00627

(22) International Filing Date: 6 December 1993 (06.12.93)

(30) Priority Data:
PL 6223 7 December 1992 (07.12.92) AU

(71) Applicant (*for all designated States except US*): MULTI-STACK INTERNATIONAL LIMITED [AU/AU]; 351 Dorset Road, Boronia, VIC 3155 (AU).

(72) Inventor; and
(75) Inventor/Applicant (*for US only*): CONRY, Ronald, David [AU/AU]; 4 Glover Close, Mooroolbark, VIC 3138 (AU).

(74) Agent: CARTER SMITH & BEADLE; Qantas House, 2 Railway Parade, Camberwell, VIC 3124 (AU).

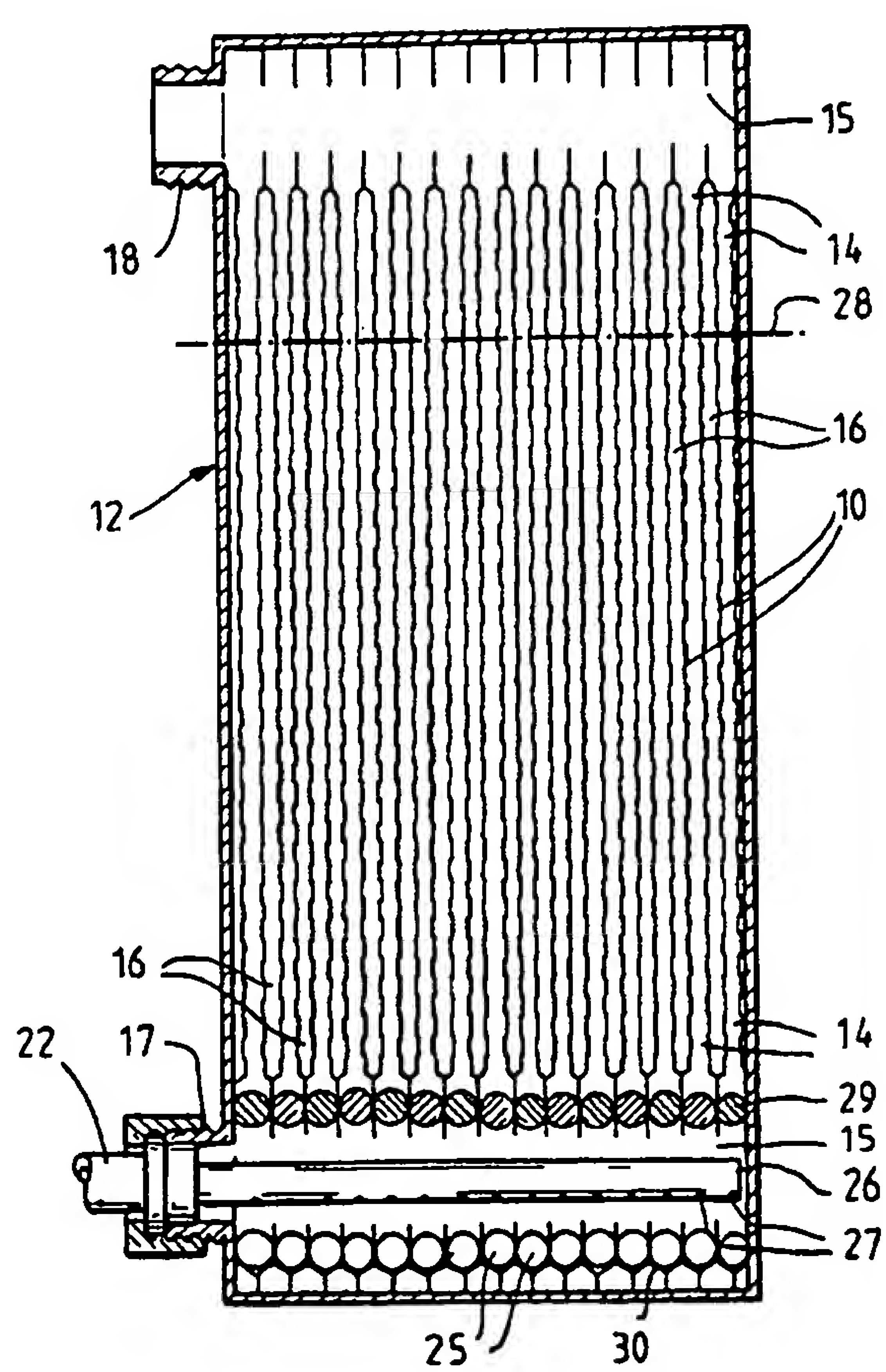
(81) Designated States: AT, AU, BB, BG, BR, BY, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, KZ, LK, LU, LV, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: IMPROVEMENTS IN PLATE HEAT-EXCHANGERS

(57) Abstract

A plate heat-exchanger (12) has an assembly of plates (16) defining and separating alternate passages (14, 16) for the flow of a refrigerant and a heat-exchange fluid. Aligned holes (15) in the plates (16) provide inlets and outlets for the refrigerant and heat-exchange fluid to the respective passages (14, 16). A refrigerant distribution tube (26, 37) is located in the refrigerant inlet defined by holes (15). The tube (26, 37) has outlet apertures (27, 38) which direct refrigerant into the refrigerant passage (14). Blanking members (29, 39) blank off part of the opening into each refrigerant passage (14) to confine the refrigerant flow from the apertures (27, 38) to a predetermined path towards the plate centreline to ensure even refrigerant distribution.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgystan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo			SE	Sweden
CH	Switzerland	KR	Republic of Korea	SI	Slovenia
CI	Côte d'Ivoire	KZ	Kazakhstan	SK	Slovakia
CM	Cameroon	LI	Liechtenstein	SN	Senegal
CN	China	LK	Sri Lanka	TD	Chad
CS	Czechoslovakia	LU	Luxembourg	TG	Togo
CZ	Czech Republic	LV	Latvia	TJ	Tajikistan
DE	Germany	MC	Monaco	TT	Trinidad and Tobago
DK	Denmark	MD	Republic of Moldova	UA	Ukraine
ES	Spain	MG	Madagascar	US	United States of America
FI	Finland	ML	Mali	UZ	Uzbekistan
FR	France	MN	Mongolia	VN	Viet Nam
GA	Gabon				

IMPROVEMENTS IN PLATE HEAT EXCHANGERS

BACKGROUND TO THE INVENTION

This invention relates to improvements in plate heat exchangers and relates particularly to improvements in such heat exchangers used as evaporators in refrigeration systems.

Plate heat exchangers have been developed for use in refrigeration systems and are extremely effective and efficient in transferring heat from a heat–exchange fluid, such as water, to the refrigerant. Such heat exchangers comprise an assembly of a plurality of metal plates which are formed, by stamping, with a series of ridges and troughs. The ridges and troughs, in the assembly, constitute pathways for refrigerant and a heat–exchange fluid. The refrigerant and heat–exchange fluid pass through the heat exchanger on opposite sides of each plate, there being refrigerant inlet and heat–exchange fluid outlet openings at one end of the heat exchanger and corresponding outlet and inlet openings at the other end of the heat exchanger.

When plate heat exchangers are used as evaporators in refrigeration systems, difficulty is often experienced in ensuring even distribution of refrigerant into the heat exchanger and the multitude of passageways between the plates. Generally, the refrigerant, prior to entry into the heat exchanger, is expanded through an expansion valve or refrigerant pressure reducing device immediately prior to entry into the heat exchanger. However, produces an uneven mixture of liquid and vapor in the refrigerant entering the heat exchanger. It will be understood that the liquid refrigerant passing through an expansion device, or pressure reduction device, causes some of the refrigerant to vaporize during the expansion or pressure reduction phase. The amount of vaporization is dependent on the temperature of the liquid refrigerant prior to the expansion device and the degree of expansion or pressure reduction. Expansion ratios of 50:1 may be experienced giving rise of up to 2%, or more, of the liquid vaporizing during the expansion or pressure reduction phase. As the vapor can account for 50% or more of the volumetric area occupied by the liquid and vapor refrigerant mixture, and as the liquid and gas refrigerant have differing densities giving rise to variable flow patterns, some passageways within a plate system of heat–exchange plates will receive more liquid refrigerant

than others. This, therefore, gives rise to unevenness in the relative amounts of liquid and vapor passing through the various refrigerant passageways thus resulting in variations in vapor temperature at the outlet. The temperature of the heat-exchange fluid flowing through the fluid passageways of the heat exchanger may therefore be lower in some passageways than in others.

In most applications where plate heat exchangers are used, the unevenness caused by the partial vaporization during the expansion process results in uneven refrigerant feed and therefore uneven performance between the passageways in the system. This means that some parts of the heat exchanger carry more of the load than others in order to achieve a given performance from the heat exchanger and maximum performance may be reduced.

Because the heat-exchange fluid used is commonly water, the passageways between some plates may also have a tendency to freeze if those plates are subject to a greater percentage of liquid refrigerant than others. This can lead to some of the heat-exchange fluid circuits freezing up whilst others continue to flow thus aggravating the difficulty and possibly leading to failure of the heat exchanger.

It is desirable, therefore, to avoid the difficulties referred to above so as to even out the flow of refrigerant through the passageways between the plates of plate heat exchangers.

It is also desirable to provide for even distribution of liquid refrigerant through the refrigerant passageways of a plate heat-exchange system.

It is also desirable to provide a relatively simple and economical liquid refrigerant distribution.

SUMMARY OF THE INVENTION

According to one aspect of the invention there is provided a plate heat exchanger comprising an assembly of a plurality of plates which separate and define passage means for the flow of refrigerant and a heat-exchange fluid, refrigerant inlet means communicating with the refrigerant passage means,

heat-exchange fluid inlet means communicating with the heat-exchange fluid passage means,

respective outlet means for the refrigerant and heat-exchange fluid,

refrigerant distribution means associated with the refrigerant inlet means and including flow control means to regulate and direct the refrigerant into the respective refrigerant passage means.

In one form of the invention, the refrigerant distribution means may comprise a tube located in the refrigerant inlet means the tube having a plurality of holes creating a row of orifices lined up to direct refrigerant to the respective refrigerant passages. The number of and size of holes may be determined in accordance with the size of plates, the number of plates forming the heat exchanger, the capacity of the heat exchanger, the type of refrigerant used and the refrigerant and system pressures, and other operating parameters. It will be understood that the number of holes does not necessarily correspond with the number of refrigerant passages, although this would generally be preferred. The sizes of the individual orifices may be varied to take account of loss of refrigerant pressure along the tube. The orifices may also be variable in size to vary the capacity of the heat exchanger in accordance with design considerations or operating parameters.

In one embodiment, a tube with the holes or orifices, or other openings, is used as the expansion device, or pressure reduction device, thus obviating the need for an external expansion valve or other expansion or pressure reduction means. With this arrangement, the size of the holes or orifices may increase gradually from an inlet end of the tube thus providing even distribution of liquid to each of the refrigerant passages.

In an alternative embodiment, a tube with the holes, orifices or other openings is used as a partial expansion or pressure reduction device in conjunction with an external expansion valve or other expansion or pressure reduction means. With this arrangement, a partial expansion or pressure reduction occurs externally and the final expansion or pressure reduction of the liquid refrigerant occurs in the refrigerant distribution means.

In a still further embodiment, an auxiliary external expansion valve or other expansion or pressure reduction means is used in conjunction with the refrigerant distribution means. With this arrangement, a second refrigerant distributor is provided in parallel with the first refrigerant distribution means. The temperature

of refrigerant after expansion through the first refrigerant distribution means is monitored in conjunction with outlet refrigerant temperature and/or pressure , heat-exchange fluid inlet and outlet temperatures and/or pressures and ambient temperature, and the external expansion valve is selectively operated as required to maintain predetermined temperature and/or pressure parameters. In this embodiment, holes provided in the second distributor are of a relatively large size to allow relatively low pressure refrigerant to be distributed to the passages.

A further feature of the present invention is the provision of partial blanking means to partially close the communication between the refrigerant inlet means and the refrigerant passage means. An opening or hole in the blanking means acts to direct the liquid refrigerant in a predetermined direction, preferably towards the centre of the refrigerant passage means, i.e., towards the centre line of the plate assembly. In one form of the invention, the blanking means may constitute the refrigerant distribution means while in another form of the invention, the blanking means is provided to work in conjunction with the refrigerant distribution means. In a preferred embodiment the blanking means comprises a generally C-shaped wire member disposed about the refrigerant inlet means between each pair of plates defining the refrigerant passage means.

In order that the invention will be more readily understood, one embodiment thereof will now be described with reference to the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional, schematic view of a standard plate heat exchanger showing the refrigerant path therethrough;

Fig. 2 is a view similar to that of Fig. 1 but showing the heat-exchange fluid path;

Fig. 3 is a view similar to that of Fig. 1 illustrating one embodiment of the present invention;

Fig. 4 is an enlarged sectional view of the base of the heat exchanger of Fig. 3;

Fig. 5 is a view taken along the lines 5-5 of Fig. 4;

Fig. 6 is a part exploded, schematic perspective view of the heat exchanger

of Fig. 3 but also showing a modification to the invention;

Fig. 7 is a cross-sectional view illustrating the modification of Fig. 6;

Fig. 8 is a view similar to that of Fig. 4 but illustrating a further form of the present invention;

Fig. 9 is a sectional view along the lines 9–9 of Fig. 8; and

Fig. 10 is a view similar to Fig. 9 illustrating a still further embodiment of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to the drawings, Figs. 1 and 2 illustrate a plate heat exchanger 12 which is an assembly of a plurality, for example, thirty (30), ribbed plates 10, the ribs of adjacent plates interengaging and adjacent plates defining passages 14 and 16 for refrigerant and a heat–exchange fluid, respectively. As water is commonly used as the heat–exchange fluid, future reference to such fluid will be made by reference to water. Also, although the drawings illustrate a counter–flow heat exchanger, it will be understood the invention also applies to a parallel flow heat exchanger.

As will be seen more clearly in Fig. 5 each plate 10 is formed with two holes 15 at each end, the holes 15, in an assembly of plates 10, forming inlets and outlets for the refrigerant and water. The plates 10 separate the refrigerant passages 14 from the water passages 16, and the plates are so formed, interengaged and sealed together, as by brazing or the like, such that fluid introduced into one of the lower holes 15 will pass through one set of the refrigerant and water passages 14 and 16 to exit from a corresponding upper hole while fluid introduced into the other of the lower holes 15 will pass through the other set of passages. A refrigerant inlet manifold 17 communicates with the openings 15 which interconnect the refrigerant passages 14 and a refrigerant outlet manifold 18 at the upper end of the heat exchanger enables refrigerant to exit from the heat exchanger. Similar water inlet and outlet manifolds 19 and 21, respectively, enable water to be circulated through the water passages 16.

In a standard plate heat exchanger 12, the refrigerant inlet manifold 17 is connected to a high pressure liquid refrigerant supply 22 through an expansion

valve 23 which reduces the refrigerant pressure. As the refrigerant passes through this valve 23, some refrigerant flashes to vapor and mixes with the liquid refrigerant. As a result, a mixture of liquid and gaseous refrigerant enters the heat exchanger 12. Because the mixture is not uniform, and as the gaseous refrigerant occupies a substantially larger volume that the liquid refrigerant, some of the refrigerant passages 14 receive more liquid than other passages so that the amount of liquid and vapour passing through each of the refrigerant passages 14 varies thus causing a variation between the individual refrigerant passages 14 in the amount of heat transferred between the water passages 16 and the refrigerant passages 14.

In Fig. 1, line 24 illustrates this variation in heat–exchange capacity where a change of phase occurs between liquid refrigerant and vapor. Line 24 is the "completion of phase change" line and the graph is indicative of the temperature of refrigerant exiting the several refrigerant passages 14. These temperatures may vary from 2°C to 11°C, depending on the proportion of vapor in the refrigerant entering the individual refrigerant passages 14.

The variation in temperature of the refrigerant vapor exiting the passages 14 results in a similar variation in temperature of water exiting the water passages 16. As shown in Fig. 2, the temperature of the water exiting the water passages 16 can vary from between 2°C to 10°C. If the water temperature in any one water passage 16 becomes so low as to cause the water to freeze, additional loads are placed on other parts of the heat exchanger and the efficiency of the heat exchanger falls dramatically. Such freezing may also lead to failure of the heat exchanger.

Referring to Figs. 3 to 7, in one form of the invention, liquid refrigerant at high pressure is supplied directly to a distribution tube 26 mounted in the refrigerant inlet manifold 17 and extending through the plate holes 15 which communication with the refrigerant passages 14. The distribution tube 26 has a number of small holes or orifices 27 corresponding in number to and carefully lined up with the refrigerant passages 14. The holes or orifices 27 may be of varying sizes increasing progressively from the manifold 17 to the rear of the heat exchanger 12 so that even distribution of liquid refrigerant is achieved to each of the refrigerant passages 14 notwithstanding the pressure drop along the tube 26.

The holes or orifices 27 provide the required pressure reduction, and accompanying expansion, of the high pressure liquid refrigerant directly into the passages 14 so that there is an even distribution of liquid refrigerant throughout the length of the heat exchanger 12. If required, an external thermal expansion valve may be used in conjunction with the distribution tube 26 to provide a desired drop in refrigerant pressure.

Because the plate holes 15 which communicate with the refrigerant passages 14 are located to one side of each plate, C–shaped washers 29 are mounted in the refrigerant passages 14 to substantially surround the respective plate holes 15 and blank off direct access to the passages 14. The opening 25 between the ends of each C–shaped washer 29 directs the liquid refrigerant downwardly and towards the centre of the passages 14 to thereby cause the liquid refrigerant to evenly disperse across the full width of the passages 14. A raised land 30 in the plates 16 defining the passages 14 also assists in guiding the refrigerant towards the centre of the respective passages 14.

Tests have shown that with the distribution tube 26 of the present invention completion of the phase change between the liquid and vapor refrigerant occurs substantially evenly across all the passages 14, as shown by the completion of phase change line 28 in Fig. 3. This results in a substantially even temperature of the refrigerant vapor and therefore a correspondingly even temperature of the water exiting the water passages 16.

By ensuring even distribution of liquid and vapor in each of the refrigerant passages 14, the efficiency of the heat exchanger 12 is substantially improved. Tests have also shown that an additional 10% in capacity is obtained from the same test heat exchanger using a distribution tube 26 in accordance with the described embodiment of the invention as compared with the normal expansion and fluid distribution methods. Thus, by utilizing the inventive features, a reduction in the number of plates in a plate heat exchanger is possible whilst allowing the minimum leaving water temperatures in any given circuit to run very close to the average leaving water temperature. Naturally, a reduction in the number of plates used in the heat exchanger in any given instance results in cost efficiencies and operation

efficiencies.

Referring to Figs. 6 and 7, the holes 27 in the tube 26 may be varied in size to take account or differing operating parameters in different refrigerant and air conditioning systems giving rise to different refrigerant requirements. For this purpose, the tube 26 has a sleeve 26a thereon which is rotatable relative to the tube 26 so as to close off or open up the holes 27 as desired. The sleeve 26a may be fixed in position by any suitable means.

Referring to Figs. 8 and 9, there is illustrated a modified form of the invention in which a second liquid refrigerant distribution tube 31 extends through the plate holes 15 which communicate with the refrigerant passages 14 substantially parallel to the first liquid refrigerant distribution tube 26. The second tube 31 is provided with holes corresponding in number to and substantially aligned with the holes or orifices 27 in the distribution tube 26, the holes 32 being of substantially larger size than the holes or orifices 27.

The second refrigerant tube 31 is connected, externally of the heat exchanger 12, to the high pressure liquid refrigerant line 33 through an expansion valve 34.

The second liquid refrigerant tube 31 provides additional refrigerant expansion capacity for the heat exchanger 12 such as may be required during start–up and during operation in low ambient temperature conditions, particularly using air–cooled condensers in the refrigerant circuit. The inlet manifold 17 also carries a temperature sensing probe 36, and other sensors (not shown) are used to determine the temperature and/or pressure at the refrigerant outlet as well as water inlet and outlet temperatures to regulate operation of the expansion valve 34. Thus, the provision of the second liquid refrigerant tube 31 improves the operating capacity of the heat exchanger 12 during a range of operating conditions thereby increasing the efficiency of the system in which the heat exchanger is installed.

As will be seen in Fig. 8 and 9, the C–shaped washers 29 are also used in this embodiment and both sets of holes 27 and 32 are directed towards the opening 25 between the ends of the washer. The orientation of the holes relative to the orientation of the tubes is arranged to ensure that the holes 32 are directed away from the tube 26.

Referring to Fig. 10, there is illustrated a further embodiment of the invention of the invention in which the refrigerant distribution is carried out by a tapered tube 37 extending through the plate holes 15 which communicate with the refrigerant passages 14. The tube 37 is similar to the tube 26 in the embodiments illustrated in Figs. 3 to 7 except that its cross-sectional area decreases from the refrigerant manifold end to the opposite end of the tube 37. The holes 38 in the tapered tube 37, which correspond to the holes 27 in the tube 26, are each of identical size and it is the tapering of the tube which ensures even distribution of liquid refrigerant through the holes 38.

Although the refrigerant passages 14 can be partially blanked off using C-shaped rings or washers 29 as shown in the previous embodiments, an alternative blanking is illustrated in Fig. 10 which comprises a blanking tube having a slot 41 along one side. The blanking tube 39 is inserted through the plate holes 15 (those holes communicating with the refrigerant passageways 14) so that the slot 41 faces generally inwardly and downwardly, similar to the location of the opening between the ends of the C-shaped washers 29 in the previous embodiments. The blanking tube may be formed of a material which can be brazed to the plates 16 around the holes 15, in which case the blanking tube 39 is inserted prior to the final brazing step in construction of the heat exchanger 12. Alternatively, the blanking tube 39 may be inserted after the final brazing step in which case the blanking tube may be formed of any suitable material, including plastics. If the material of the blanking tube is a resilient material, the tube 39 may be formed with an outer diameter larger than the diameter of the plate holes 15 whereby insertion is effected by compressing the tube so that the slot 41 along the one side is closed thereby reducing the tube diameter sufficiently to enable it to be inserted through the plate holes 15. If desired, circumferential grooves may be formed in the blanking tube 39 so that, when correctly located in place, the edges of the plate holes 15 are seated in the circumferential grooves. Sealing materials or adhesives may be used, if desired, to locate and seal the blanking tube 39 in its desired position.

It will be understood that modifications of the invention may include other means for throttling the flow of liquid refrigerant from the refrigerant inlet manifold

17 to the individual passages 14. Provided such throttling is variable to even out the flow of liquid and vapor refrigerant to each passage 14, similar efficiencies could be expected to those of the particular embodiments described above.

It will be appreciated that the present invention also allows for the elimination of the normal expansion valve or other types of expansion or refrigerant pressure reduction devices thus allowing for reduced manufacturing costs whilst giving a marked increase in performance of the heat exchanger.

Claims:

1. A plate heat exchanger comprising an assembly of a plurality of plates which separate and define passage means for the flow of refrigerant and a heat–exchange fluid, refrigerant inlet means communicating with the refrigerant passage means,

heat–exchange fluid inlet means communicating with the heat–exchange fluid passage means,

respective outlet means for the refrigerant and heat–exchange fluid,

refrigerant distribution means associated with the refrigerant inlet means and including flow control means to regulate and direct the refrigerant into the respective refrigerant passage means.

2. A plate heat exchanger according to claim 1 wherein the refrigerant inlet means comprises aligned holes in the plates and the distribution means comprises a tube located in the refrigerant inlet means, the tube having a plurality of apertures forming the flow control means and from which refrigerant is directed into each of the refrigerant passage means.

3. A plate heat exchanger according to claim 2 wherein said plurality of apertures vary in size from one end of the tube to the other.

4. A plate heat exchanger according to claim 2 wherein adjusting means is provided to selectively change the cross–sectional area of the apertures to thereby change the flow of refrigerant therethrough.

5. A plate heat exchanger according to any one of claims 2 to 4 wherein said tube and plurality of apertures are of a size to constitute a refrigerant pressure reduction device reducing the pressure of liquid refrigerant supplied to the tube to a predetermined relatively low pressure.

6. A plate heat exchanger according to claim 2 wherein said tube tapers from a larger cross–sectional area at a refrigerant inlet end to a smaller cross–sectional area at the end remote from the inlet end.

7. A plate heat exchanger according to any one of the preceding claims wherein partial blanking means is provided in either each refrigerant passage means to partially surround the refrigerant inlet means or in the refrigerant inlet means, said

partial blanking means confining refrigerant flow from said distribution means along a predetermined path defined by an opening in the partial blanking means.

8. A plate heat exchanger according to claim 7 wherein said opening is located to direct refrigerant flow towards a centreline of the respective refrigerant passage means.

9. A plate heat exchanger according to claim 7 or claim 8 wherein said flow control means directs refrigerant from the distribution means towards said opening.

10. A plate heat exchanger according to any one of claims 7 to 9 wherein said partial blanking means comprises a plurality of C–shaped members sealed to the plates defining each of said refrigerant passage means and surrounding holes in the plates which holes define the refrigerant inlet means.

11. A plate heat exchanger according to any one of claims 7 to 9 wherein said partial blanking means comprises a tube–like member having a slot along one side, the member being located in the refrigerant inlet means defined by aligned holes in the plates, the slot in the tube forming said opening.

12. A plate heat exchanger according to any one of the preceding claims wherein a second refrigerant distribution means is disposed in the refrigerant inlet means, said second refrigerant distribution means being connected to a high pressure liquid refrigerant supply through a selectively operated pressure reduction valve.

13. A plate heat exchanger according to claim 12 wherein said second refrigerant distribution means comprises a tube having a plurality of relatively large holes to direct refrigerant to each of said refrigerant passage means.

14. A plate heat exchanger comprising an assembly of plates which separate and define alternate passages for the flow of a refrigerant and a heat–exchange fluid, the plates each being formed with holes which, in the assembly, define inlet means and outlet means by which refrigerant and heat–exchange fluid is caused to flow through the respective passages, a refrigerant distribution tube extending from one side of the assembly through the refrigerant inlet means, said distribution tube being closed at its end remote from said one side of the assembly and having a plurality of apertures each aligned with and directed towards one of said refrigerant passages to direct refrigerant supplied to the tube into said passages.

15. A plate heat exchanger according to claim 14 wherein said distribution tube is connected to a high pressure liquid refrigerant line whereby said refrigerant is supplied to said tube under relatively high pressure and said tube and apertures constitute a pressure reduction means by which the pressure of the refrigerant is reduced as it enters the refrigerant passages.

16. A plate heat exchanger according to claim 15 wherein an auxiliary refrigerant distributor extends through said refrigerant inlet means substantially parallel with said tube.

17. A plate heat exchanger according to claim 16 wherein said auxiliary distributor tube is connected to said high pressure liquid refrigerant line through a pressure reduction device so that the pressure of refrigerant in said auxiliary distributor tube is relatively low, said auxiliary distributor tube having relatively large holes through which said relatively low pressure refrigerant is distributed to said refrigerant passages.

18. A plate heat exchanger according to claim 17 wherein said pressure reduction device is selectively operated in accordance with load on the heat exchanger as determined by inlet and outlet temperatures of said refrigerant and heat–exchange fluid.

19. A plate heat exchanger according to any one of claims 14 to 18 wherein said apertures in said distribution tube increase in size from the said one side to the remote end.

20. A plate heat exchanger according to any one of claims 14 to 19 wherein the cross–sectional areas of said apertures is variable.

21. A plate heat exchanger according to claim 20 wherein a sleeve is engaged on the distribution tube, the sleeve having one or more openings aligned with said apertures and being selectively movable to vary the size of the apertures.

22. A plate heat exchanger according to any one of claims 14 to 21 wherein blanking means is provided in the refrigerant inlet means or in each refrigerant passage to confine the flow of refrigerant from the inlet means to a predetermined path defined by an opening in the blanking means.

23. A plate heat exchanger according to claim 22 wherein said blanking means

comprises C–shaped wire members sealed in the passages and extending around the inlet means.

24. A plate heat exchanger according to claim 22 wherein said blanking means comprises a substantially C–shaped, tube–like member positioned in said inlet means.

25. A plate heat exchanger according to any one of claims 14 to 24 wherein said distributor tube has a cross–sectional area decreasing from said one side of said assembly to the remote end.

26. A plate heat exchanger substantially as hereinbefore described with reference to the accompanying drawings.

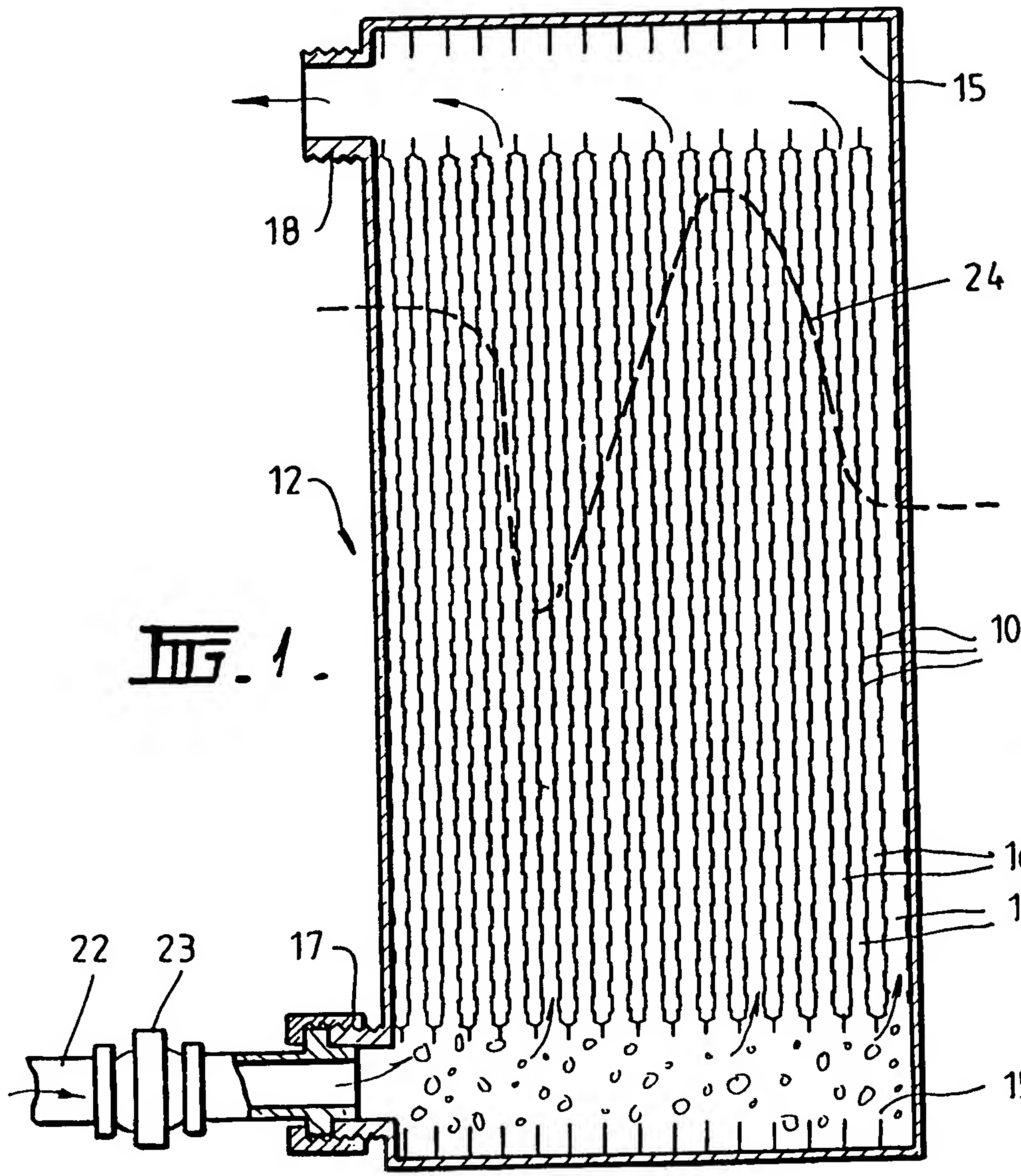


FIG. 1.

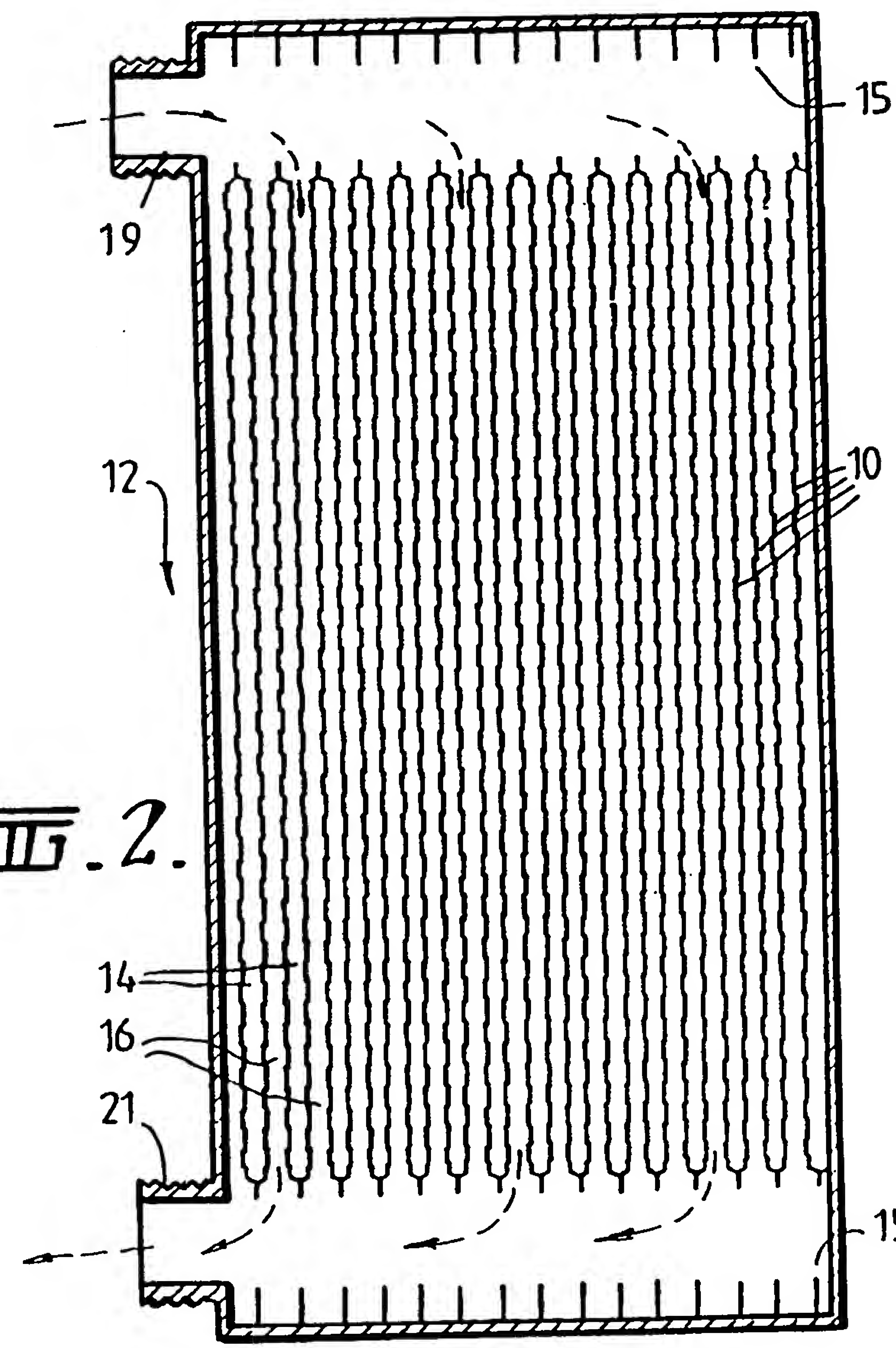
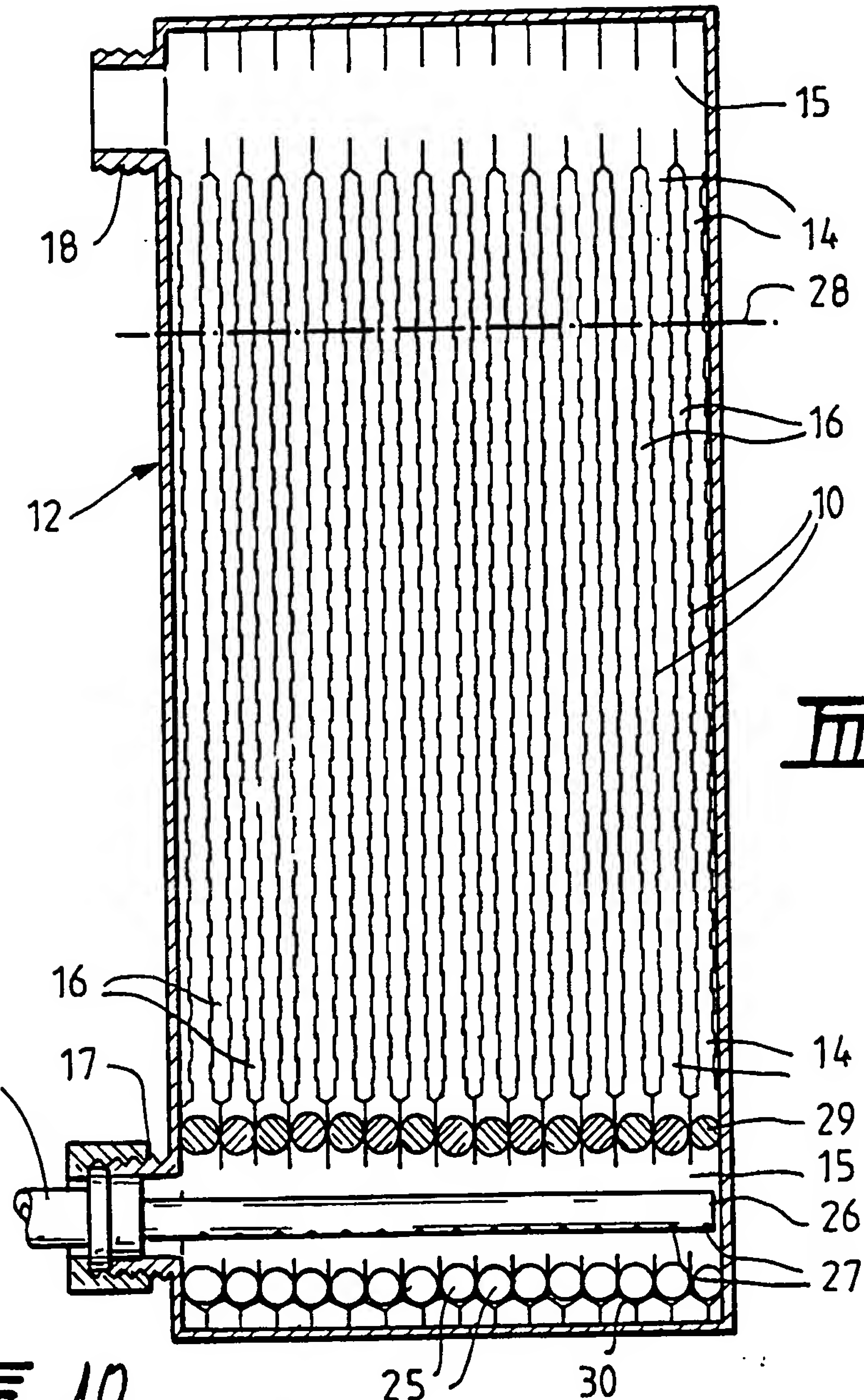


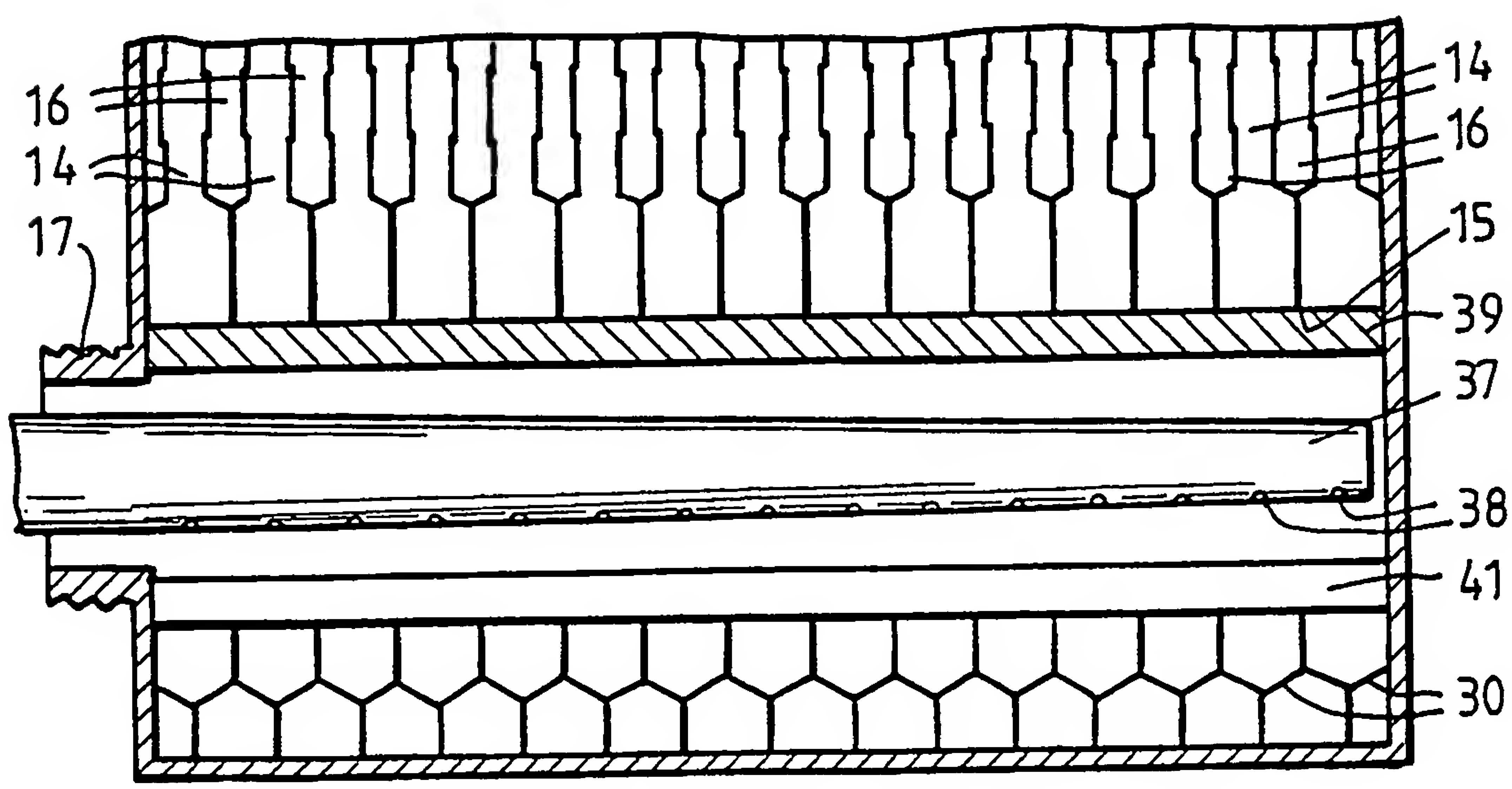
FIG. 2.



15
14
18
28
16
12
10
16
14
22
17
29
15
26
27
25
30

FIG. 3.

FIG. 10.



14
16
16
14
17
15
39
37
38
41
30

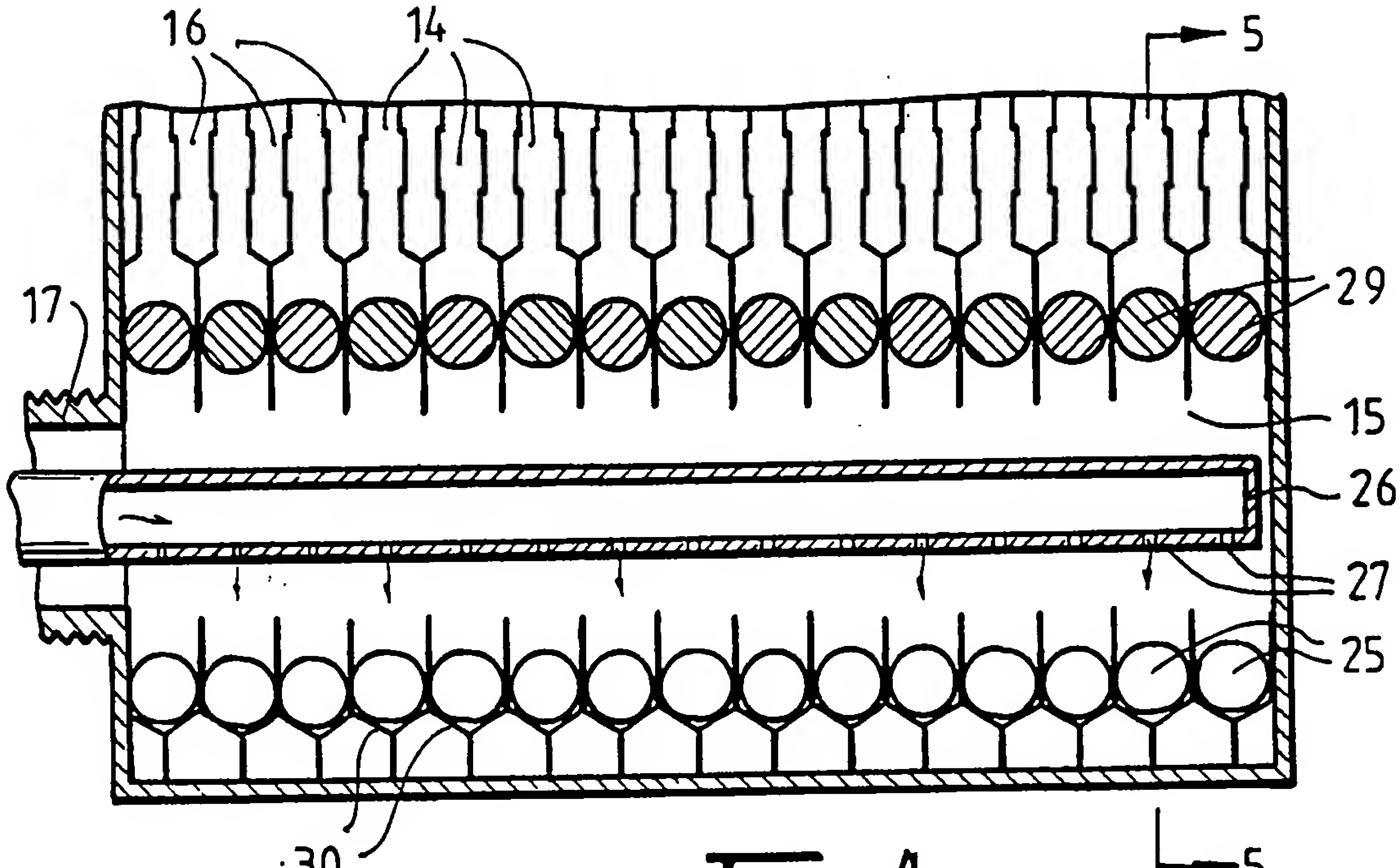


FIG. 4.

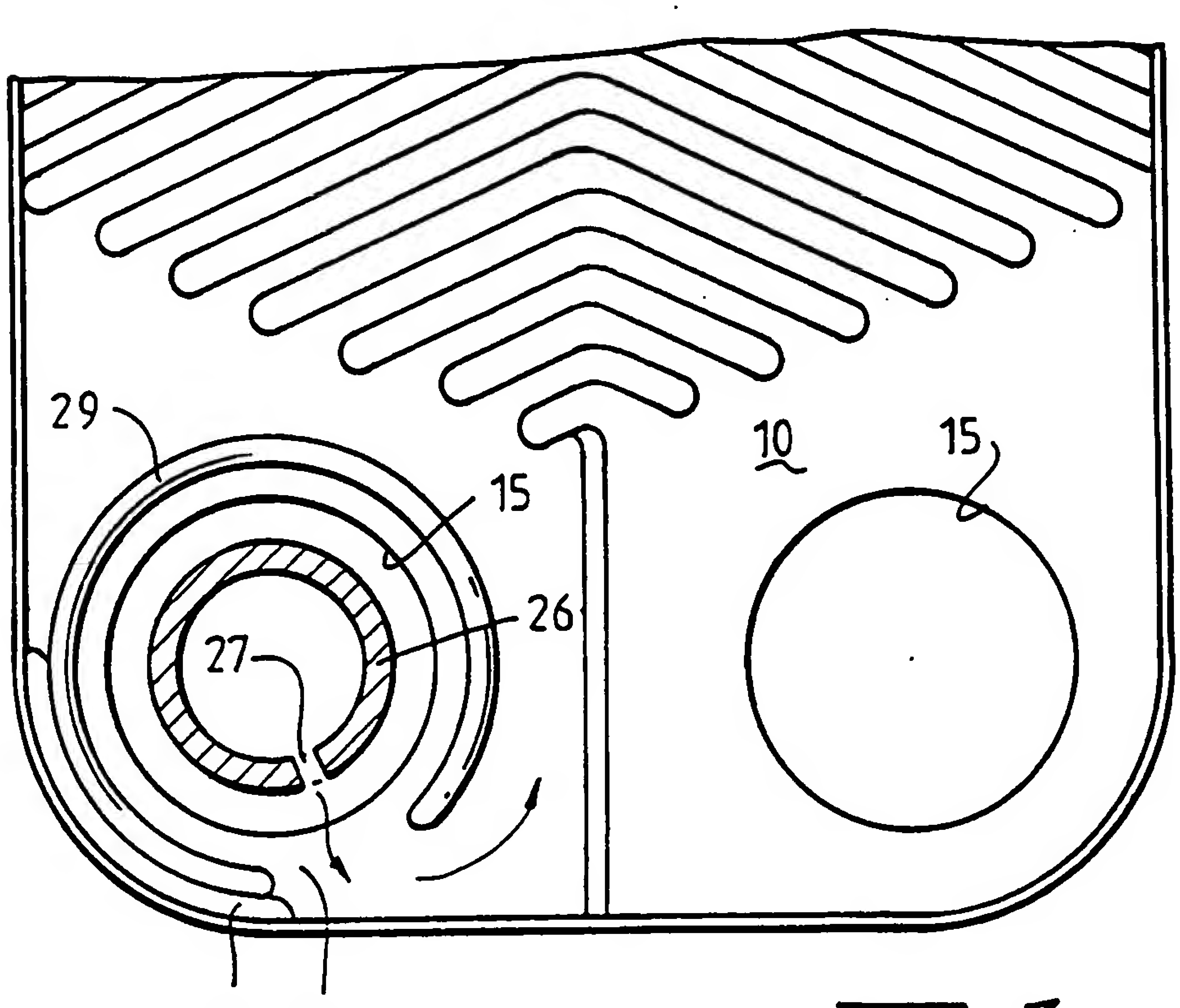


FIG. 5.

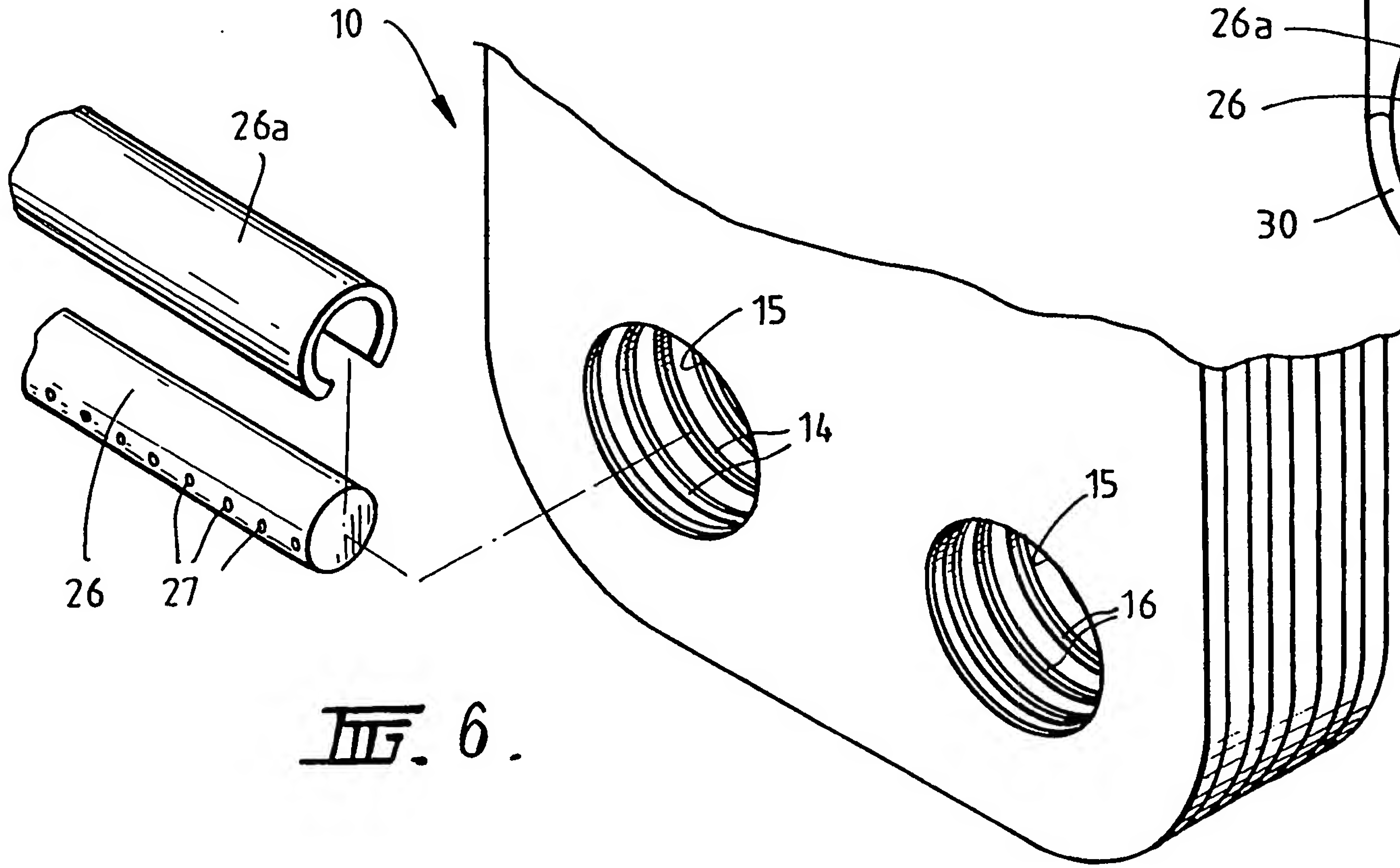


FIG. 6.

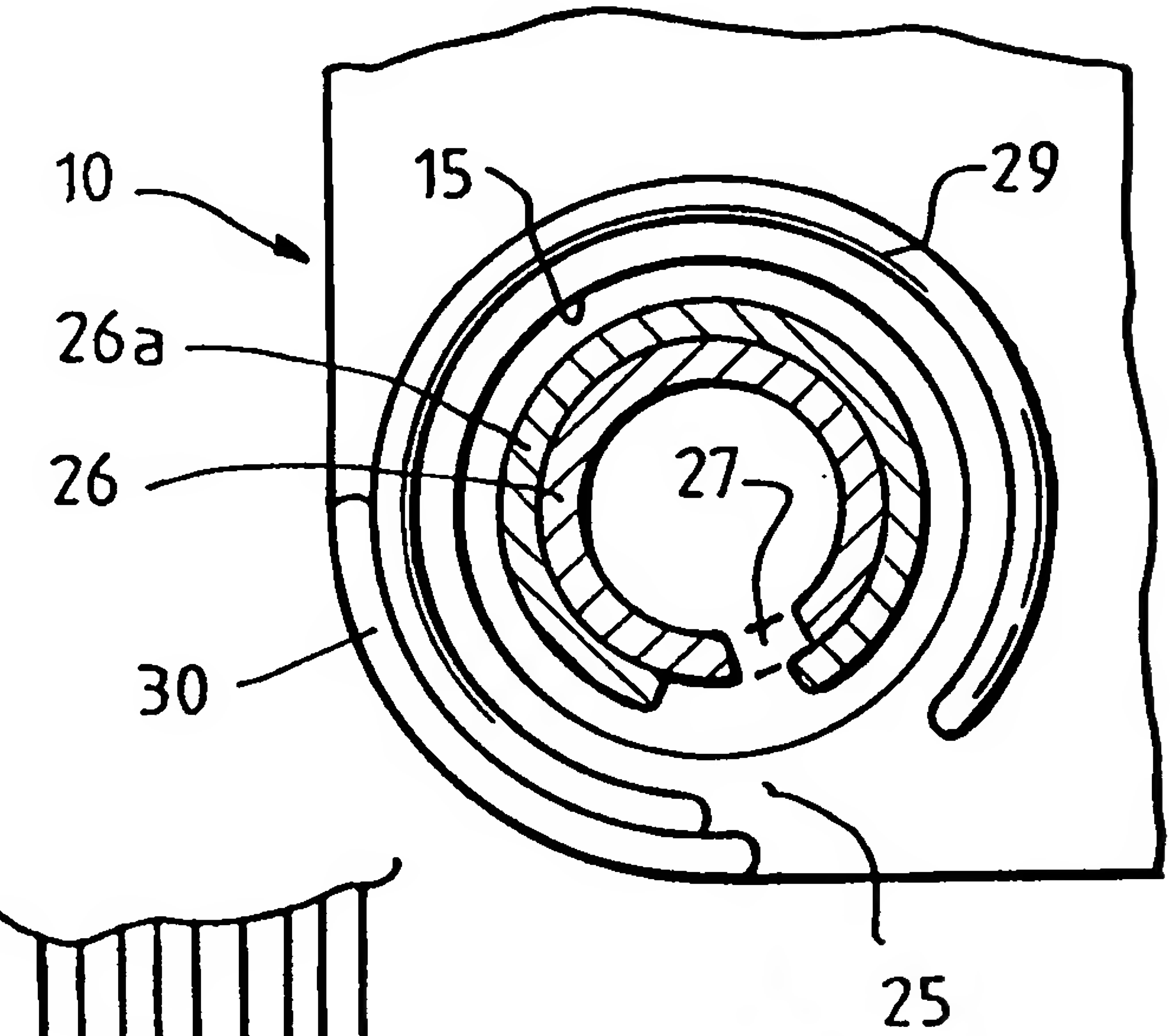
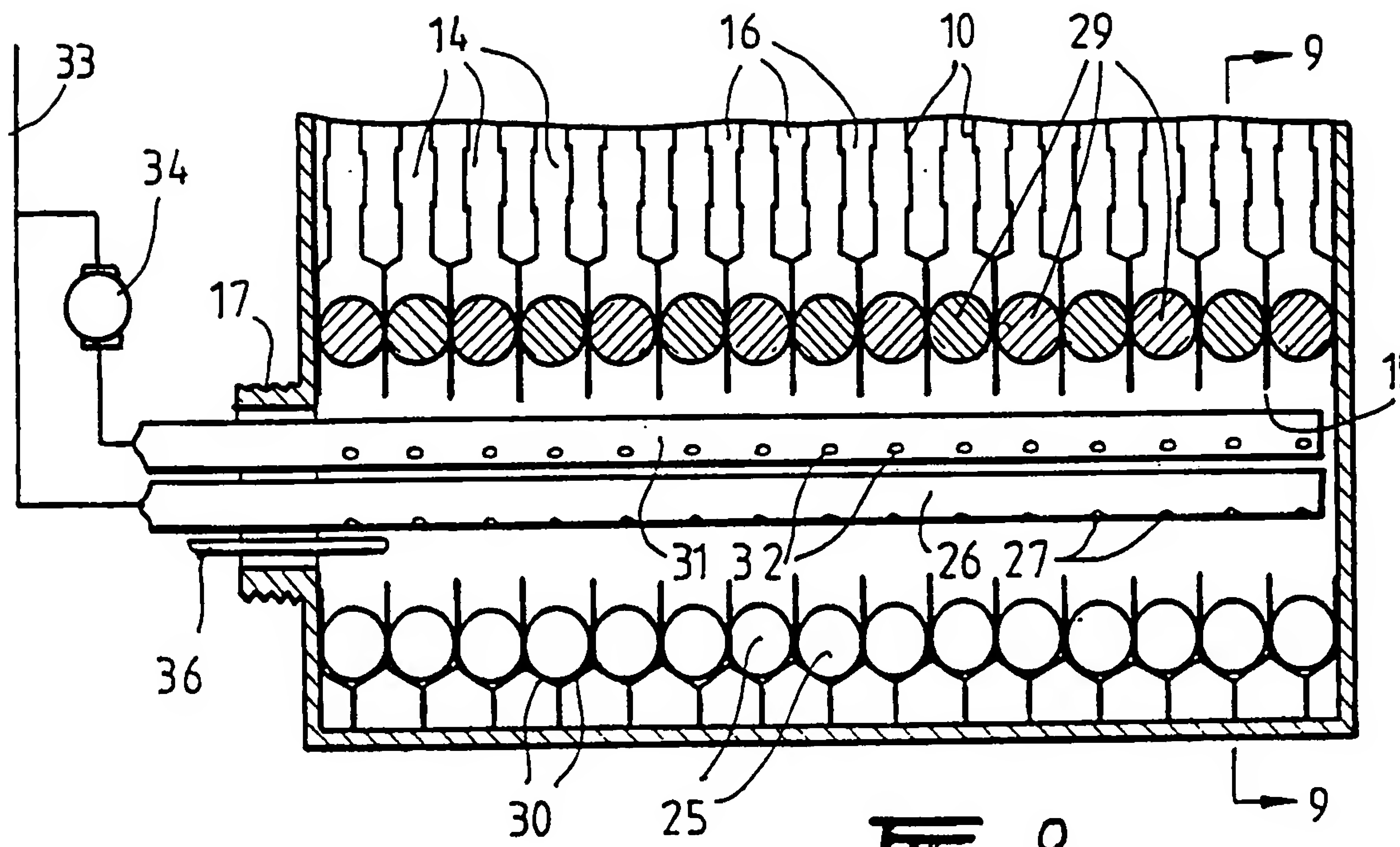
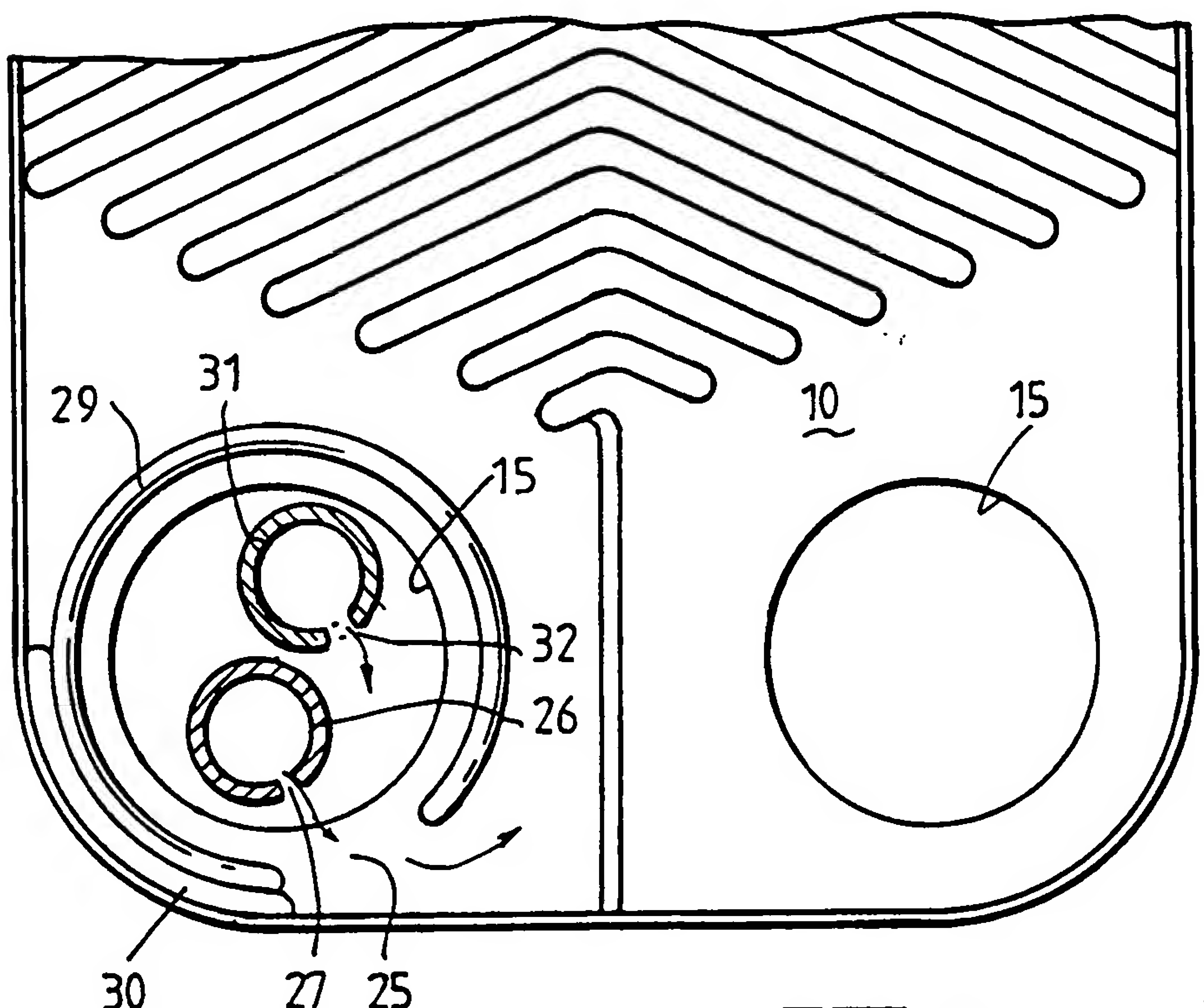


FIG. 7.



33
34
17
14
16
10
29
9
15
31
32
26
27
36
30
25
9

FIG. 8.



31
29
15
10
15
32
26
30
27
25

FIG. 9.

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.5 F28F 3/00, 3/12, 27/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC F28F 3/00, 3/12, 27/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

AU : IPC as above

Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	GB,A, 1558575 (ALFA-LAVAL AB) 3 January 1980 (03.01.80)	
A	GB,A, 1500379 (BORG-WARNER CORPORATION) 8 February 1978 (08.02.78)	
A	US,A, 3862661 (KOVALENKO et al) 28 January 1975 (28.01.75)	
A	AU,B, 48389/72 (462004) (TRANTER MANUFACTURING INC.) 2 May 1974 (02.05.74)	
	(continued)	

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 March 1994 (14.03.94)	18 March 1994 (18.03.94)
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No. 06 2853929	Authorized officer B. NGUYEN Telephone No. (06) 2832306

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
A	AU,B, 25834/54 (163445) (GENERAL MOTORS CORPORATION) 20 May 1954 (20.05.54)	
A	Derwent Abstract Accession no. 93-197185/24, Class Q75 Q78, WO,A, 9311399 (LONG MFG LTD) 10 June 1993 (10.06.93)	

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
GB	1558575	CA IT	1078372 1086913	DE JP	2748224 53055545	FR SE	2369529 7612047
GB	1500379	BR SE	7503205 7505863	CA US	1018150 4002201	DE US	2521279 4081025
WO	9311399	AU	29387/92				
							END OF ANNEX